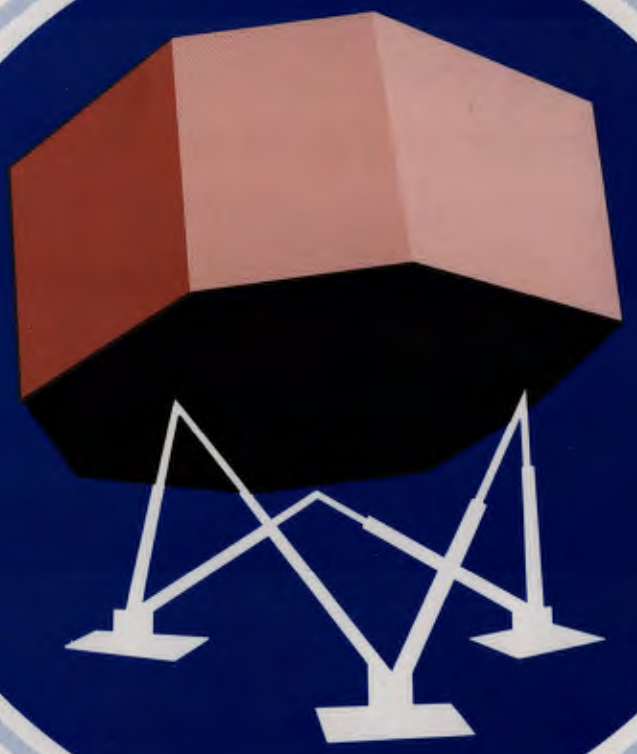
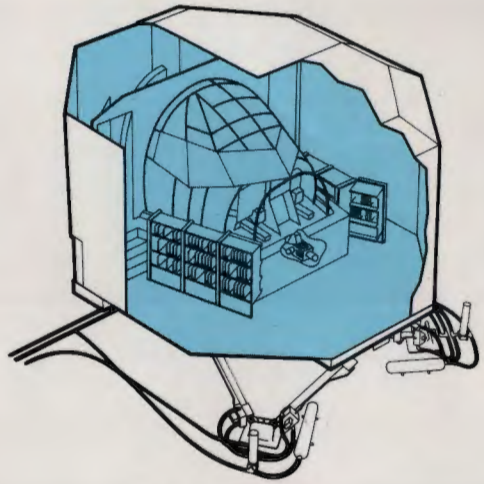
With an eye on the 80's . . .

Advanced Simulation Technology

AST





Advanced Simulation Technology (AST)

Advanced Simulation Technology (AST) is a revolutionary approach to simulator design. It constitutes the most significant advancement in the simulation field since the development of digital devices in the 1960's.

AST is an equipment updating program designed to present the latest simulator technology in a new packaging approach to achieve today's flight training objectives. It is the culmination of an extensive, long-term development program. The result is a *Link** flight simulator with significant improvements in performance, reliability, maintainability and life cycle costs.

Early in 1973, Link initiated the AST development program with three defined objectives:

- ☐ Utilize the new technology available to improve equipment performance without attendant cost increases.
- ☐ Adopt an equipment standardization program to increase operational availability and training effectiveness.
- ☐ Consider the user's acquisition and ownership costs as a major design criterion and develop systems and techniques that reduce these costs.

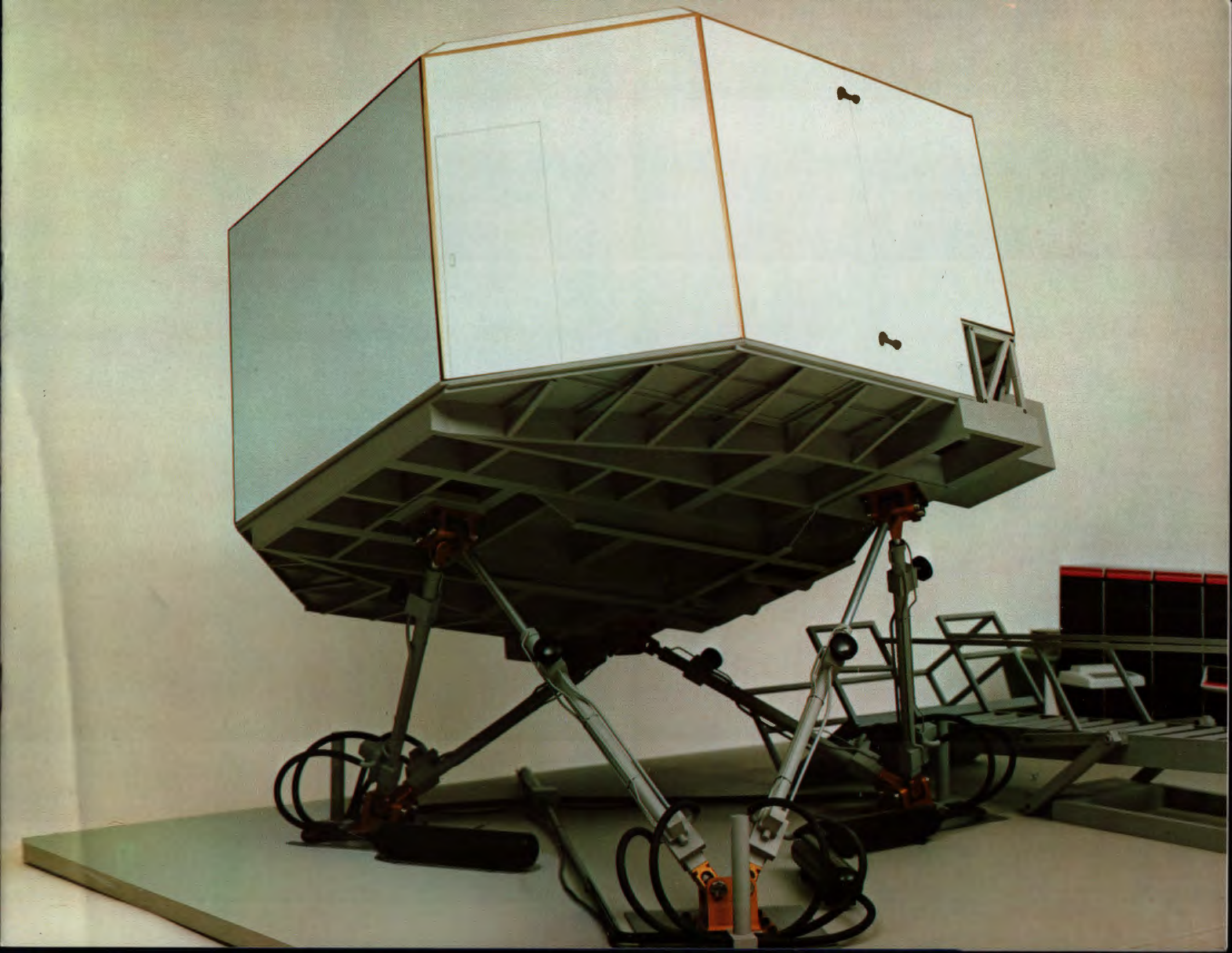
These three objectives have been met.

Improved performance was achieved in part by utilizing the latest state-of-the-art mini-computers — successfully proven in over 200 simulator applications to date. A sophisticated on-line fault detection program is incorporated to provide hard-copy readout for maintenance personnel. A completely redesigned six-degree-of-freedom motion system improves motion cueing. Control feel is improved by the use of a new hybrid control loader. Quadraphonic sound heightens the realism of noise simulation. Instructional facilities are improved in both physical hardware and software availability.

In achieving higher reliability, Link designed the AST simulator with significant reductions in components by using miniaturized electronics and standardized hardware elements. The new motion system operates at lower hydraulic pressures, resulting in reduced noise levels and virtually eliminating leakage problems. Special emphasis has been put on all aspects of aircraft instrument reliability. The AST fault detection system anticipates a component failure by detecting its degradation in time to allow replacement prior to actual failure and resultant training time loss.

Today ownership costs are of prime importance. AST addresses this concern by reducing spares requirements through the use of standardized elements. Loss of training time is significantly reduced with an automatic monitor and fault detection system. Since this system pinpoints the failure, maintenance time and mean time to repair (MTTR) are reduced. Component miniaturization and motion system improvements reduce the power requirements for both operating and air conditioning the AST simulator. Safety of trainees and other personnel has been increased by G-limiting devices in the new AST motion system. Other safety features include an enclosed—yet accessible—maintenance work area and a self contained fire suppression system.

These benefits—improved performance, increased operational availability and reduced ownership costs—are available NOW, in a *Link** AST simulator.



Card files are mounted in hinged gate assemblies, maximizing equipment serviceability. Power supplies are located at the bottom of the card bin, connected by bus to the cards above.

AST: A New Interconnection System

The AST interconnection system uses the most advanced technology to locate linkage and conversion electronics close to the cockpit equipment they serve. Standardization and miniaturization of components permit mounting all necessary equipment in six racks—three on either side of the cockpit. Link has incorporated into this interface a unique test system: Automatic Continuous Closed Loop Test System (ACCTS). Dedicated conversion devices are contained on the system cards at the cockpit.

The AST design eliminates numerous cables and equipment cabinets saving some 80% of space formerly required for conventional simulator interface. All digital transmissions in the AST interconnection system are carried in serial fashion by a single seven-wire conductor from the master controller to the subcontrollers.

This master controller in the computer cabinet can be located up to 300 feet from the subcontrollers on the cockpit. The master controller can communicate with up to 19 subcontrollers—each of which in turn communicates with up to 16 system cards in the bins.

Since this capacity is far in excess of most present simulator requirements, future simulator technology developments can be accommodated by AST.

Equipment maintenance time is significantly reduced by ACCTS—a series of simultaneous tests performed while the simulator is being used for training. In many cases ACCTS can reduce the fault isolation to one of three chips on a card. A hard-copy printout of fault information is provided for maintenance personnel.

The AST interconnection system is remarkably compact thereby reducing space requirements. The digital to analog conversions are accomplished near the hardware they serve, resulting in high signal-to-noise ratios.

The inherent flexibility built into the AST design—especially in the master controller capacity, standardization of card files and backplanes and simplification of printed circuit cards—facilitates updating. Many changes, which in conventional systems would require hardware modifications, can now be made in the software.

Substantial economies are realized by ACCTS—a unique test system significantly reducing costly equipment maintenance and even more costly training time loss. Real-time testing in the *Link** AST is the most advanced in the simulator industry.

AST electronic packaging showing ribbon cables connecting back plane of printed circuit file to flight compartment system.

AST: A New Power System

The newly designed AST power system is based on two basic principles: power supplies are distributed in close proximity to their driven electronics, and a low impedance bus concept is used to distribute D.C. power.

Ease of maintenance is achieved by locating the power supplies at the base of the card bin connected by bus to the cards above. These card files are mounted on gates making them readily accessible.

The relay of A.C. power to on-board equipment affords better signal-to-noise ratios and simplifies transmissions. It includes circuit breaker protection of individual lines and utilities.

The AST power distribution system also includes automatic fault detection and monitoring. Again, a hard-copy printout is available for maintenance personnel.

The entire AST power system requires only about one-fifth the space of conventional systems. What once occupied an entire cabinet is now reduced to a single card bin. This space economy translates into lower building and operating costs.

The only simulator elements still located on the floor in the AST configuration are computer cabinets, A. C. power cabinet, and motion electronics cabinet.

AST: A New Motion System

AST motion is provided by a six-degree-of-freedom synergistic system of an entirely new design. Significant improvements in performance, maintainability and safety are realized with this new motion system.

An improved dynamic response and smoother directional transition are achieved through the use of the latest state-of-the-art components, resulting in higher performance parameters than previous designs. Exacting military standards for motion cueing are met and—in many instances—exceeded.

The number of moving parts has been reduced increasing the reliability of the AST motion system. Maintenance is simplified by the substitution of solid state electronic components.

Complex plumbing and cabling in conventional motion systems are drastically reduced in the new AST six-degree-of-freedom motion system.

A new actuator is incorporated in the AST motion system. This actuator uses a hydrostatic bearing which reduces static friction forces by some 75%—resulting in a smoother directional transition of the motion leg. Imbedded in the actuator is an ultrasonic linear displacement transducer which eliminates mechanical coupling and resultant play between the actuator and sensor. This unique feature assures accurate position feedback.

Link has incorporated in this AST motion system a major safety improvement—a simple yet ingenious device called the "piccolo tube." The system is inherently foolproof since it has no moving parts.

Not only does this design achieve a smooth system erection, but—more importantly—it provides a unique energy absorbing technique which limits maximum G forces imparted to the cockpit to safely acceptable levels, even under worst-case failure.

The complex mass of plumbing in conventional motion systems is significantly reduced—by 60%. The AST motion system uses lower operating pressures (1,000 psi) which permit the substitution of vane type pumps, thus reducing noise levels around the motion system and in the pump room.

Standardized design, off-the-shelf parts, simplified plumbing, strengthened platforms, new geometrical design, streamlined motion legs, quieter pumps and condensed electronics—all contribute to lower acquisition, maintenance and facility costs, while increasing training effectiveness and safety.

A single motion electronics cabinet contains all the controls and indicators, servo electronics and logic circuitry needed to ensure safe operation of the entire AST motion system.

This top-down, cut-away view of the AST model shows equipment racks on either side of the cockpit and the instructors' station behind the captain's position.

AST: A New Aural Cue System

The AST aural cue system provides quadraphonic outputs. This sound directionality adds realism to the simulation of a wide variety of sounds from taxi rumble to aerodynamic hiss. The aural cue system cards contain all electronics associated with sound simulation including input/output (I/O) conversion and closed loop testing (ACCTS).

A single bus replaces the complex array of cables and wires of previous designs. Only seven PC cards are required instead of 30 cards in conventional systems—another example of the economy of space inherent in the AST design.

Realistic aural cues enhance the simulation realism in the AST system, contributing to overall training effectiveness while reducing costly complexity.

AST: A New Packaging Concept

AST includes an entirely new approach to simulator packaging. Recognizing that the simulator is a training device and not an aircraft, Link has departed from the conventional practice of building the simulator exterior to resemble the simulated aircraft. In its place is a functional design which emphasizes an optimal training environment, serviceability, reduced facilities requirements and adaptability to future needs.

The AST concepts of digital bus interconnections and distributed interface electronics have made this new ap-

proach to simulator packaging possible. After analyzing various transport aircraft flight compartments, Link devised a layout which permitted the location of electronics as close as possible to the aircraft hardware serviced. A unique enclosure design resulted in a modularization which greatly facilitates maintenance.

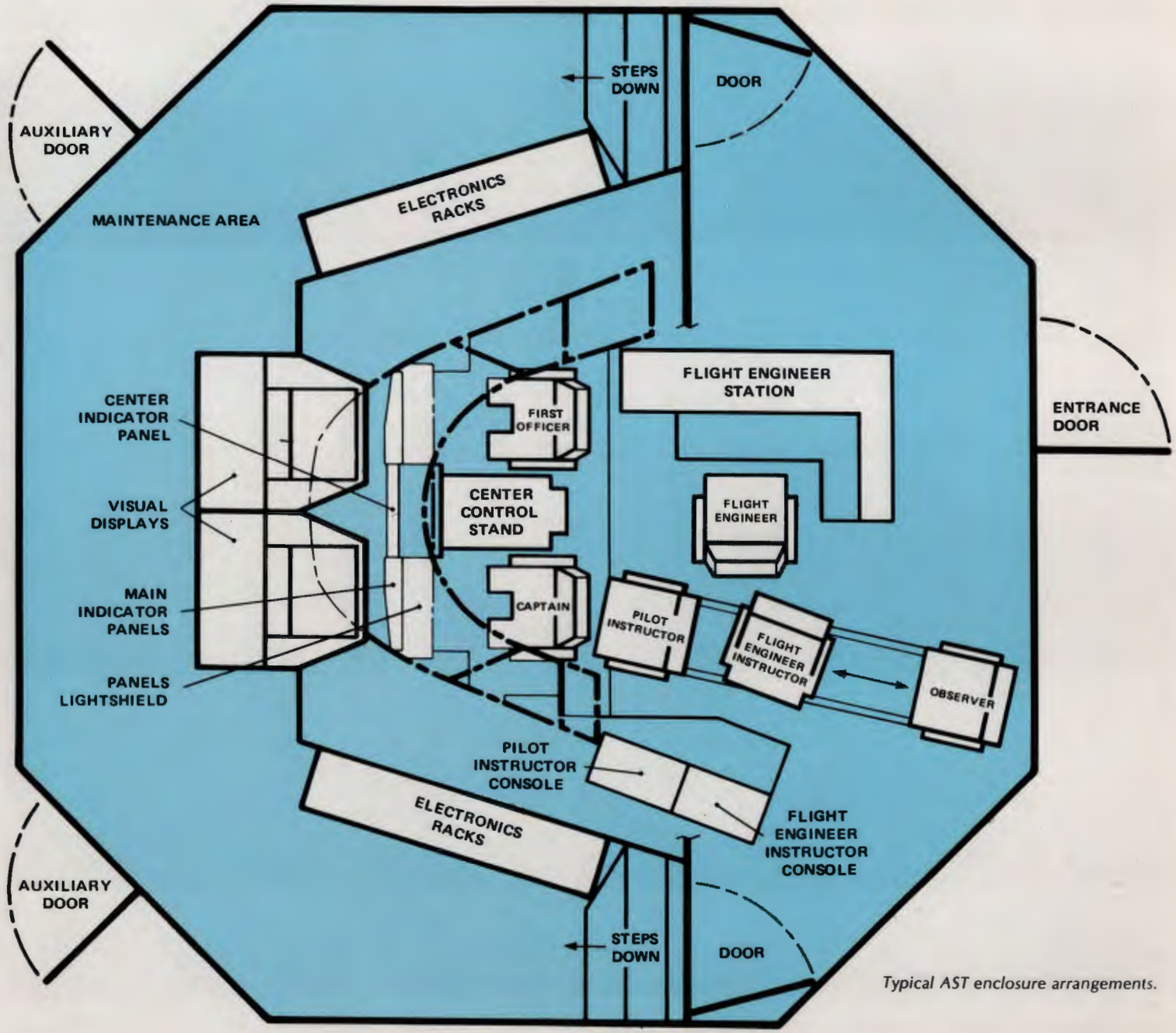
The cockpit interior in the AST design remains an exact replica of the flight deck of the aircraft simulated. Since simulation electronics are not packaged in the cockpit interior, the area is less cluttered and resembles the aircraft even more.

The open-rack construction with electronics mounted in hinged gate assemblies maximizes equipment serviceability. With the cockpit strut construction, maintenance can be accomplished from outside as well as inside, providing ready access to instrument panels and cable runs.

The octagonal, honeycomb aluminum structure permits a closed clean environment which facilitates air conditioning and equipment cooling. The enclosure provides not only comfort but also safety since the design can easily accommodate an effective fire suppression system.

The light-tight visual display area eliminates the need for external visual equipment enclosures. Ample space is provided here for any type of multiple display visual system.

Even ancillary equipment—lighting, staircases, chairs—have been redesigned increasing the overall effectiveness of the simulator.



Typical AST enclosure arrangements.

AST: A New Control Loading System

The AST control loading system is designed to improve system response and performance characteristics.

The control loaders use a hybrid—analog/digital—design to take advantage of both analog smoothness and digital accuracy. Analog computations are used in slow term functions such as pilot force integrations, viscous damping and friction effects. Digital computations are used to insure accuracy in high speed functions such as stick forces, hinge moments and trim forces. This unique design approach allows the constants of integration to be programmable, ensuring system flexibility.

A low friction actuator improves response, while a linear feedback device eliminates the mechanical play experienced in previous designs.

The AST control loading system is based on extensive development and years of experience. The end result is a design which reduces complexity while improving overall performance.

AST: Advanced Instructor Station

The AST instructor area, with facilities for a pilot instructor, flight engineer instructor and an observer, is located within the simulated flight compartment immediately behind the captain's position. This vantage point permits over-the-shoulder instruction while the instructor controls are still within reach. CRT's and panels in the AST design are fully recessed, giving instructors more room to conduct effective training sessions.

The high-quality CRT system provides clear alphanumeric and graphic displays. Both the pilot instructor and the flight engineer instructor are provided with separate, identical CRT display units and control panels. The control panels can be used interchangeably in the event of a malfunction thereby avoiding costly interruptions of training sessions.

The control panels and CRT displays are the only devices needed by instructors to effectively control and monitor the training problem. The controls and status indicators on the control panel are functionally grouped and color coded to facilitate rapid identification and access. The panel design affords maximum training situation control while requiring a minimum of operation control.

AST real-time interface equipment is used to connect the control panels to the computer. This improves the instructor control system reliability and facilitates maintenance.

The programmable nature of the CRT displays permits changes in the type or arrangement of information presented, or the expansion of training capabilities, without hardware changes.

Link Division's many significant innovations in this area have produced an advanced instructor station which is versatile, operational, maintainable and practical. It is designed to achieve a wide variety of training objectives efficiently and economically.

AST: Summary

In summary, the *Link** Advanced Simulation Technology program represents a major departure from previous simulator designs. The scope of the technological improvements covers virtually every facet of the flight simulator.

The Link Division pioneered the development of the flight simulator in 1929 and has continued as the leader in simulation technology. The challenge of the 1940's was met with the familiar "Blue Box." The challenge of the 1960's was met with the digital simulator. In meeting the challenges of the 1970's—the international energy crisis coupled with persistent inflation—Link has designed the AST simulator, and arrived at the state-of-the-art of the 1980's.

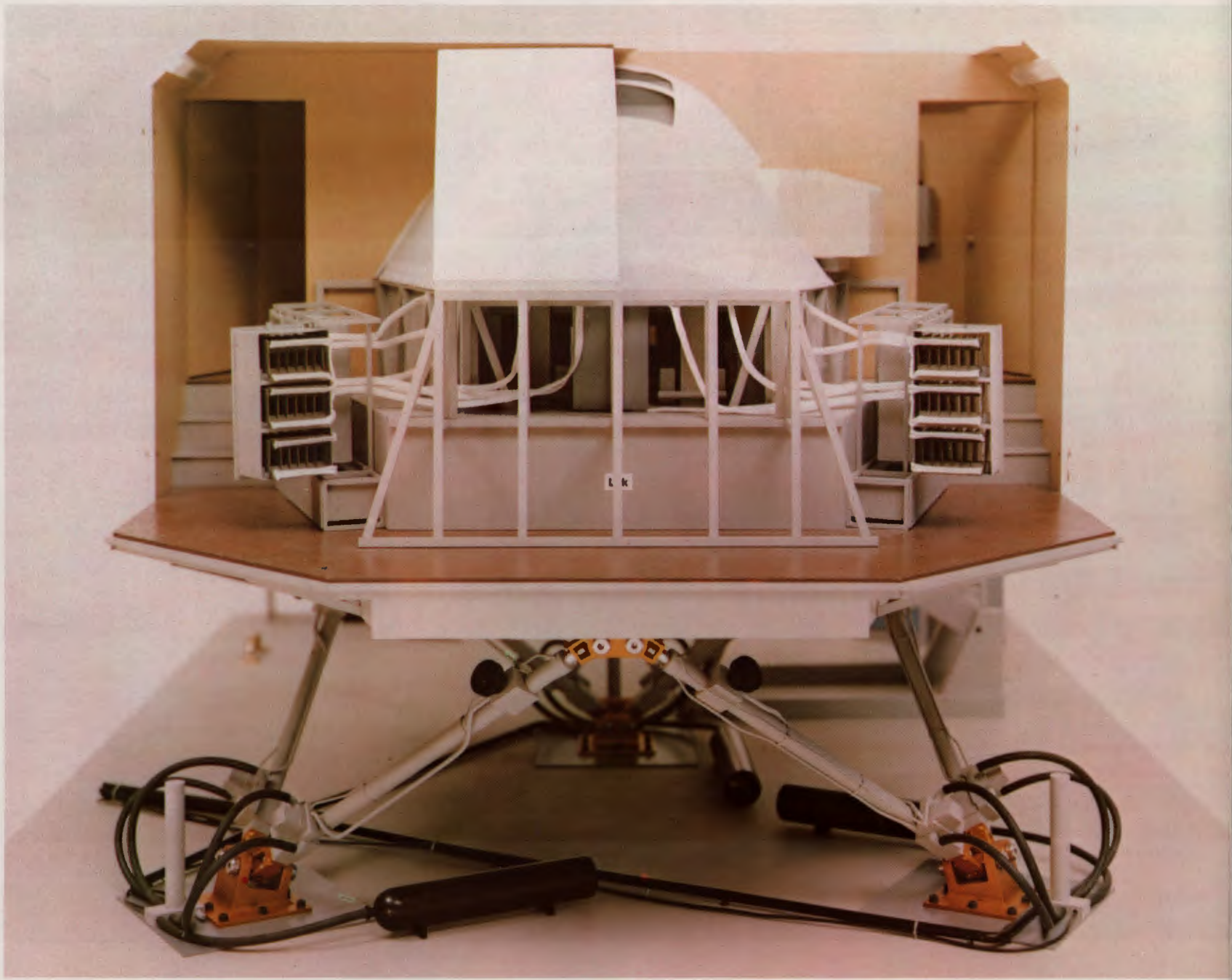
Basic AST technological concepts are designed to reduce potential equipment obsolescence. AST is designed to provide the world's airlines with the improved performance, higher reliability and reduced ownership costs which are their objectives—and Link's.

AST is not a "paper system." Its hardware elements are incorporated in a number of military simulators, already in operation. AST is available now. It is offered as the latest simulation technology, yet avoids the usual risks associated with prototype procurements.

Since AST was introduced to the world's airlines in the summer of 1976, several have purchased such simulators. AST was chosen over the competition for four basic reasons:

- ☐ Because AST is an advanced, yet proven simulation system.
- ☐ Because AST is owner oriented.
- ☐ Because AST is designed for tomorrow's training needs.
- ☐ Because AST is built by LINK.

*A trademark of The Singer Company



For more information on AST, write or call us:

Link Division
The Singer Company
Binghamton, N.Y. 13902
(607/772-3011)

Link-Miles Division
(Singer U.K.)
Lancing, Sussex BN158UE
(Lancing 5881)

Link

A DIVISION OF THE SINGER COMPANY

Binghamton, New York 13902

LP #1714 2M-5-77 Printed in U.S.A.